

PHYLOGENY OF THE GENERA WITHIN THE FAMILY BOPYRIDAE

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The Bopyridae is a parasitic family of isopod crustaceans, either living in the branchial cavity of the decapod crustaceans, or clinging to their abdomen. The family includes more than 50 genera which fall into six groups according to the external features of male and female. Provisionally, these groups may be called *Pseudione*-group, *Bopyrus*-group, *Cepon*-group, *Orbione*-group, *Athelges*-group, and *Hemiarthrus* — or *Phryxus*- group.

The phylogeny of bopyrid genera has been discussed on the basis of the female characters, but with only partial success. The external features of the females may be under the influence of the structure and respiratory physiology of the host branchial cavity. But, there is no reason to believe that the males, which are dwarf, may be affected by such factors. It is presumed that the evolution of the males follows an orthogenetic course. Moreover, the changes of the two sexes do not necessarily keep pace with each other. In discussing the phylogeny of Bopyridae, therefore, it is necessary to take the male characters also into account.

In the evolution of the bopyrid females three different processes are involved. The first is the gradual degeneration of organs which are far better developed in the free-living isopods. The pleopods provide the best example. The second is the fusion of somites. The head is occasionally fused with the first thoracic somite, and the abdominal somites become step by step fused together as the evolution proceeds. The third is the excessive development of organs peculiar to the Bopyridae. For example, expansion of the frontal lamina and coxal plates in *Orbione*-group, elongation and ramification of lateral plates and pleopods in *Cepon*-group etc. belong to this process.

Thus, the directions of evolution of the six groups are determined, for the first ground, by the varied development of the coxal plates, lateral plates, pleopods and oostegites in the female. Parallel with these, the fusion of somites occurs in every group, though not similar in extent.

The evolution of the males directs to the degeneration of pleopods and the fusion of somites, similar to that of the females. The stage in which this fusion takes place, however, is different between the sexes.

Within the entire Bopyridae, the genus *Pseudione* is considered nearest to the ideal ancestral form, from which almost all the genera descended.

The females of this genus have distinct somites, narrow coxal plates, moderately developed lateral plates and five pairs of biramous foliaceous pleopods. The males have distinct somites and five pairs of uniramous pleopods. This genus shows the most generalized structure.

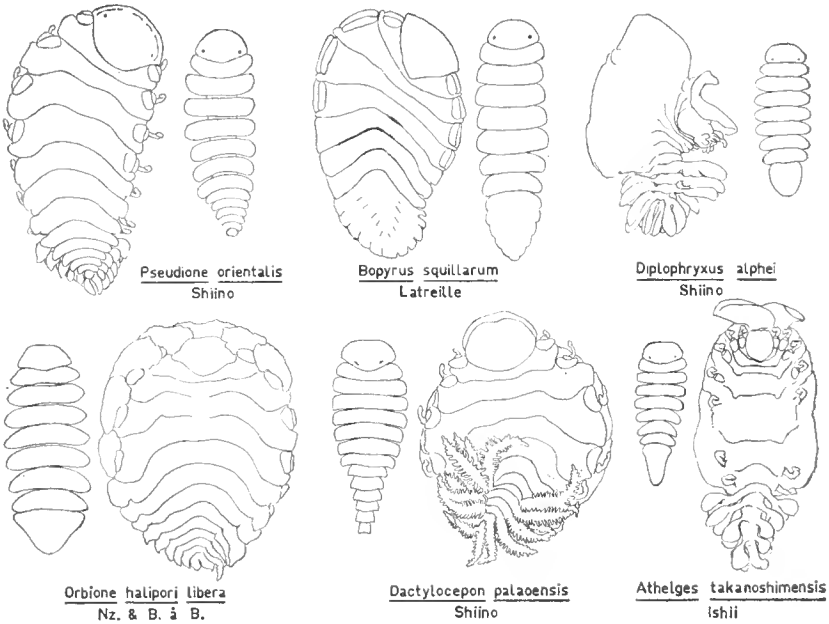


FIG. 1

Of all the genera, *Pseudione* is the nearest to the other suborders of Isopoda and, as a matter of fact, it does not show any substantial difference from the Cymothoidea except for the structure of the mouth parts.

It is the largest genus comprising about 50 species. Though uniform in the plan of structure, those species show varieties of shapes, from which various features of other genus groups can reasonably be derived by slight modification. These facts suggest that *Pseudione* is in the earliest stage of the evolutionary history of the Bopyridae, and not yet fixed in the direction of evolution.

In all the genera other than *Pseudione*, the host species of one bopyrid genus are restricted to a rather small systematic unit, such as family, subfamily, or even genus. *Pseudione*, however, comprises the parasites of at least eight families of Anomura and Caridea. It is not so specialized as to be restricted to a narrow limit of host animals. In short, *Pseudione* is in the earliest stage of parasitic adaptation and has the largest potentialities of undergoing changes in various ways.

This does not necessarily mean that *Pseudione* is most primitive, but indicates that the evolution to various directions was made possible in

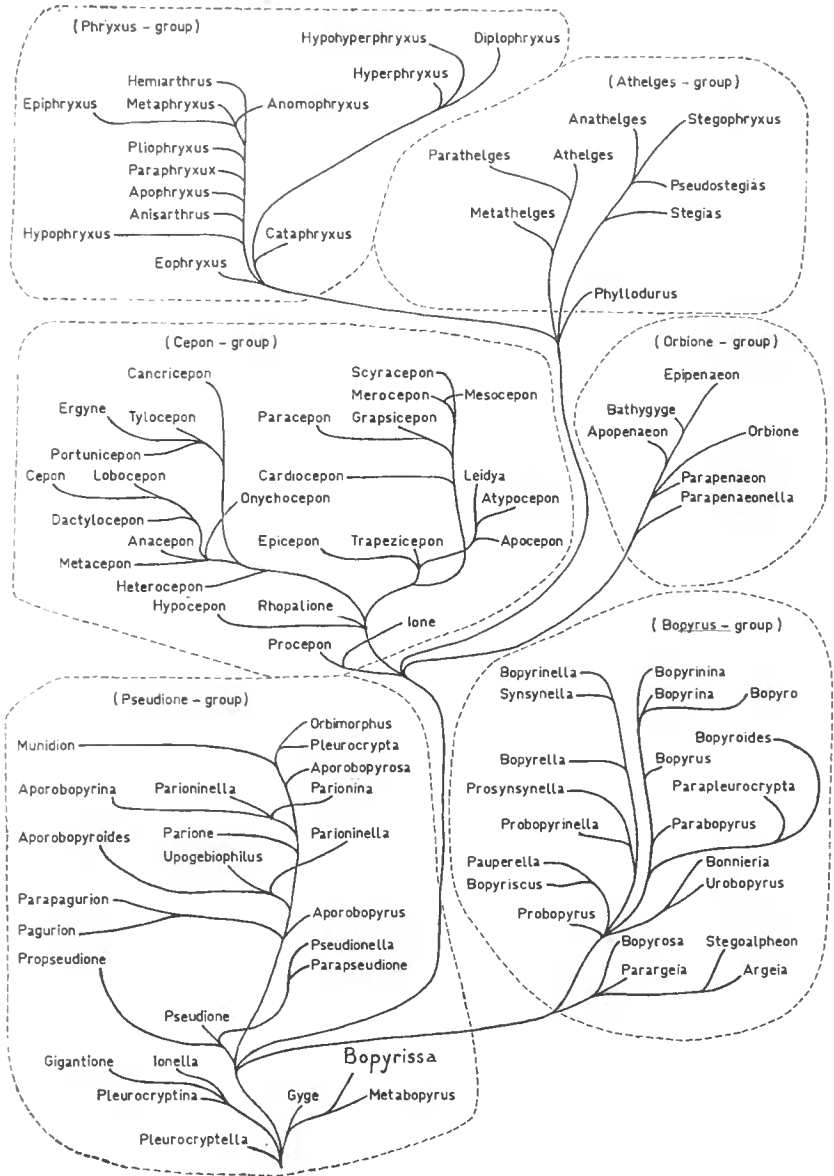


FIG. 2

the stage of this genus. The most primitive is *Pleurocryptella* which has the rudiments of additional oostegites on the last two pereonites of the female, and retains the uropods in the male. This genus living on the Galatheidea gave rise to a few parasites of Anomura besides *Pseudione*.

Six groups aforementioned were directly or indirectly derived from *Pseudione* (fig. 2).

Evolution of *Pseudione*-group derived from the genus *Pseudione* trends to the suppression of coxal plates and lateral plates, and the gradual fusion of male pleonites. In *Orbione*-group, the excessive development of lateral plates and coxal plates and the complete fusion of the male pleonites constitute the typical feature of its evolution. In *Cepon*-group, the lateral plates and pleopoda gradually become elongated and ramified in the females, and the male pleonites remain separated. Both the groups were derived from *Pseudione*, passing through *Procepon*, the most primitive member of *Cepon*-group. *Procepon* has the lateral plates and pleopoda, which are well suggestive of the same structures of *Cepon*-group, on one hand, it possesses well-developed coxal plates, to which the origin of the similar structure of *Orbione*-group may be assigned, on the other hand. *Bopyrus*-group has the oostegites much reduced, the pleonites of both the sexes showing gradual union, and the pleopods undergoing gradual degeneration. This group is believed to be derived directly from *Pseudione*. *Athelges*- and *Hemiarthrus*-groups are rather closely allied to each other, and characterized by the distinctness of lateral plates and pleopods from the pleonites in the female, and by the complete union of pleonites in the male. Having their origin in common, both the groups descended from *Phyllodurus* which has a striking morphological resemblance to *Cepon*-group in spite of the abdominal habitat.

Considering from the host-parasite specificity, the ancestral form of Bopyridae probably commenced its parasitic life on *Galatheidea*, as this may be seen from the most primitive *Pleurocryptella*. *Pseudione* derived from this extended its hosts to other decapods. The form which continued to live on Anomura gave rise to *Pseudione*-group, and the form that transferred to Caridea developed into *Bopyrus*-group. Another member of *Pseudione*, which lived on Thalassinidea, derived *Procepon*, and through this genus one line changed their host to Penaeidae, on which the development of *Orbione*-group was attained, and the other line transferring to Brachyura underwent the development of *Cepon*-group. One of the primitive members of *Cepon*-group changed its location on the host from the branchial cavity to the abdomen, and became *Phyllodurus* living on Thalassinidea. One of the descendants of *Phyllodurus* returned to the Caridea, but to the different site, the abdomen, and gave the origin of *Hemiarthrus*-group, and the other that preferred the pagurid hosts became *Athelges*-group. The Bopyridae is thus monophyletic in origin.